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Use and relevance of bibliometrics for nurses

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Abstract A vast and increasing scientific literature is published each year, including books, journals, research articles and reviews. One approach to determining the value of an academic publication involves measuring how often other academic writers or researchers refer to or cite it. This is the essence of bibliometrics. This article examines how bibliometrics has developed. It describes how analysing citations provides a measure of the influence of specific articles (individual article citations), to compare different journals (journal impact factor) and to examine the output and impact of individual academics (the h-index). Particular reference is made to nursing. Using citations should not be the only way that the value of scholarly work is judged, because there are limitations in using this method. However, bibliometrics provides an important, feasible and systematic means of reaching judgments about the importance of published works. As a result, it can be useful for examining the productivity and influence of individuals and institutions and for comparing different disciplines and journals. Keywords academia, academic publications, bibliometrics, citations, h-index, impact factor, journal impact, metrics, publications

Key words: citations, peer-reviewed publication, academic performance, metrics, journal impact, research quality, research excellence framework

Aims and Intended Outcomes:
This article aims to define bibliometrics and provide relevant contextual information about its development and use. It outlines the main ways in which bibliometric data are collected and used to provide measures of productivity, quality and impact. The article provides examples of the application of bibliometric measures in nursing and the health sciences. It considers the main strengths and limitations of applying bibliometric methods to nursing and scientific scholarship. After reading this article and completing the time out activities you should be able to:

- Understand what is meant by bibliometrics.
- Explain how journal impact factors are calculated.
- Define the h-index.
- Describe the importance of bibliometrics to scholarship.
- Recognise the limitations of bibliometric data.

Relevance to The Code
Nurses are encouraged to apply the four themes of The Code: Professional Standards of Practice and Behaviour for Nurses and Midwives to their professional practice (Nursing and Midwifery Council (NMC) 2015). The themes are: Prioritise people, Practise effectively, Preserve safety, and Promote professionalism and trust. This article relates to The Code in the following ways:

- It discusses the use of various bibliometric measures that can assist nurses to practise effectively by enabling them to appreciate the impact of published works.
- The Code states that nurses must make sure any information or advice given is evidence-based. Knowledge of bibliometrics may assist nurses in evaluating the importance and impact of information provided by particular journals, articles and researchers.
- Nurses can use the information about bibliometrics to support students' learning and enhance their skills. The Code states that nurses must support students' and colleagues' learning to assist them to develop their professional competence and confidence.
- The use of bibliometrics may assist nurses in undertaking learning and professional development activities, which is a requirement of revalidation. This may also enable nurses

to maintain and develop their competence and improve their performance, as part of the theme of promoting professionalism and trust.

Introduction

Bibilometrics is the term used to describe the statistical analysis of written works, including books, articles, and other publications. It is most relevant to scholarly or academic publications, particularly to scientific articles, and is a widely used way of measuring and comparing the impact and importance of individual authors or researchers, of particular papers or articles, and of various journals. It can be used to examine the productivity of individuals, departments and institutions, and different fields or disciplines. Bibliometrics is based on the practice of citing and referencing, which is common across all areas of academic study.

> **TIME OUT 1**
> What is a citation? Why is it important when writing an essay, article or book chapter to note accurately the sources that have been used? Is there a specific word used to describe failure to note a source that has been used in your work?

Citations and the use of citation counts

A citation is the noting or referencing of a particular source, typically a published article or book, in a body of work, which acknowledges its relevance to the point being made or topic being addressed. In general, the term 'citation' refers to the combination of the in-text reference (which can be in the form of abbreviated author details - termed Harvard referencing; or sequential numbering – termed Vancouver referencing), together with the entry in the bibliography or reference list which provides the full details of the source. The practice of citing and referencing is an essential part of scholarship, because it shows how the author's arguments or ideas relate to and build upon available knowledge in the field. In this way citations link current work to the wider field and show how the new knowledge or interpretation fits with current research and opinion, thus locating the work in a broader context. Failing to cite other sources diminishes the value of the new work, because it omits the vital context of the relevant literature. It may also be a form of academic dishonesty, termed *plagiarism,* if other work has been consulted and used, but the author fails to acknowledge this by providing the relevant citations (Masic, 2013).

Initially, bibliometric measures involved simple counts. One of the earliest noted applications of this approach was in 1927, when two academic chemists from one small college in the US examined one volume (all of the issues published over one year) of a particularly representative and well-regarded scientific periodical, which was the name used for journals at the time. They tabulated, in ranked order, details of the number of times other journals were the source of references in the journal. The purpose was to provide an objective way of identifying the most important journals in the field, in this instance, chemistry, and thus which of the available journals were essential for inclusion on the college library subscription list (Gross and Gross, 1927).

With the advent of computer technology, sophisticated approaches to examining publication outputs have been developed. The development and widespread use of electronic bibliographic databases, such as MEDLINE and CINAHL (Cumulative Index to Nursing and Allied Health Literature), enable detailed and accurate counting of citations. Bibliographic databases retain vast numbers of publication records. From these databases, information about the ways articles are used by other authors can be detailed and reported.

Citation counts of published articles remain the basic source of bibliometric measures. They are increasingly used in making judgements about the relative importance and value of particular articles, journals, authors, research institute departments, and universities (Jackson et al 2009). There are a range of ways in which the available data about publications can be used to assist people's evaluations and understanding of the relative impact and value of published works. This article will describe and provide some critical commentary on the main approaches used.

TIME OUT 2
Have you used electronic bibliographic databases such as MEDLINE, PsycINFO and CINAHL? Are you aware of the free, publicly available databases such as PubMed (www. ncbi.nlm.nih.gov/pmc), which provides free access to MEDLINE, and Google Scholar (scholar.google.co.uk)? Search these sites for articles using keywords relevant to your field of practice, and select an article to see how many times it has been cited by other articles.

Citation counts and journal impact factor

Citation counts have been used since the 1960s to provide a way of ranking and comparing journals. This was originally undertaken in the form of the Science Citation Index, which later became the Journal Citation Reports (Garfield 2005). The process is based on counting the number of times articles from a specific journal are cited in any journal in a particular year, usually the most recent year for which those data are available. For example, the Journal of Advanced Nursing impact factor for the year 2016 would be calculated by counting all the citations, published in any journal in 2016, for all Journal of Advanced Nursing articles that were published in the preceding two years (2014 and 2015), divided by the total number of articles published by that journal in those two years (Box 1).

BOX 1. Calculating a journal's impact factor

Journal impact factor for 'Journal X' in 2016 =

$$\frac{\text{Number of citations in 2016 for all articles published in Journal X in 2014 and 2015}}{\text{Number of articles published in 2014 and 2015 in Journal X}}$$

The resulting figure is the journal impact factor, which shows how often the average article in a particular journal has been cited over the course of one year. This provides a way of comparing the relative impact of journals, which, importantly, does not rely on either journal size (the number of articles in each issue), or issue frequency (Cross, 2005).

TIME OUT 3
What journals for medical science and social science, including nursing, have you come across? If you were to rank these journals according to the average number of citations their articles obtain, which disciplines do you think might come highest and which particular journals would rank highest?

By using the journal impact factor calculation, different journals in various fields or disciplines can be compared. Journal impact factors for science and social science journals are available at the Web of Science indices, published and updated annually by the Thomson Reuters Corporation and available via subscription. The 2016 Journal Citation Report (Web of Science, 2016) provides ranking and scores for more than 11,000 journals from 81 countries in 234 disciplines, with categories ranging from astronomy and astrophysics to anthropology, and from water resources to women's studies.

Journal impact factors for the five highest-rank science and social science journals published in 2016 for journal impact 2015 were (Web of Science 2016):
1. CA: A Cancer Journal for Clinicians (137.58)
2. The New England Journal of Medicine (59.56)
3. Nature Reviews Drug Discovery (47.12)
4. The Lancet (44.00)
5. Nature Biotechnology (43.11)
The journals with the lowest journal impact factors were: the Journal of Camel Practice and Research (0.027); Plastic Surgery (0.022); and Nursing History Review (0) (Web of Science, 2016).

Many of the journals listed in the 2016 Journal Citation Report (Web of Science, 2016) have journal impact factors of around 1.00; in 2016, this accounted for nearly 12,000 journals. The mid-point (median) value for the entire list is 1.34, which means that half of all the listed journals have an impact factor lower than this, and half of them have an impact factor higher than this.

Examining the impact factors of all journals together does not provide the best or most useful comparisons. In general, journal impact factors make most sense when comparing the available journals in a particular field or discipline. The categories available in the Web of Science journal citation reports site include areas and disciplines such as nursing, psychiatry, psychology, endocrinology and metabolism, geriatrics and gerontology, nutrition and dietetics, and oncology. These categories are typically used in making judgements about the relative value or prestige of an individual journal. Institutions, departments, research groups and individual scholars make decisions about where they may submit their research articles based, in part, on these rankings. Similarly, impact factors are used as part of the evaluations made about the value of an individual researcher's or research group's contributions (Smith and Watson, 2016).

A total of 230 journals were listed in the 'nursing' category in the 2016 Journal Citation Report (Web of Science, 2016). They were ranked by journal impact factor, from 3.56 to 0.00, with the International Journal of Nursing Studies ranked highest. As with the total journal list, the distribution of impacts is not uniform across the whole list; around half of the nursing journals listed have an impact factor of 1.00 or below. The current impact factor for some of the best-known academic nurse journals are: Journal of Clinical Nursing (1.34), Nurse Education Today (1.59), Journal of Advanced Nursing (1.92), International Journal of Mental Health Nursing (1.94) and Cancer Nursing (2.02) (Web of Science 2016).

As well as their use for academics and academic evaluation, journal citation counts are important for libraries in deciding which journals should be purchased and form part of their collections (Dong et al 2005, Garfield 2007). They may also be valuable for advertisers and sponsors to inform their decisions about which journals to use or support.

TIME OUT 4
Do you think the number of times an article is cited is a useful measure of its importance? What factors do you think might affect individual article citations? Consider whether some disciplines or fields might be cited more often than others, and which ones. Consider whether certain types of article, such as reviews, guideline summaries, or new research methods, might be highly cited. What other factors might be relevant?

Individual article citations

Counting the citations of an individual article can be used to examine the number of times it is referred to (cited) in other publications. While the journal impact factor provides an average figure for all the articles in a particular journal over one year, there is considerable variation in the citation counts between articles. In any journal, however high-ranking, there will be some articles that are highly cited, whereas others may not be cited at all. The approach generally used to examine and report individual article citations does not depend on a particular time period, unlike the journal impact factor. It is based on the entire available history of the article; that is, the total number of citations since it was published. Some articles are widely cited; for example, a list in 2014 of the 100 most highly cited articles revealed that each article had at least 12,000 citations (Van Noorden et al, 2014).

In general, the number of citations for different articles in any journal is skewed, with a relatively small proportion being widely cited and a large number achieving more modest citation numbers. It appears that around 20% of all published articles account for 80% of the citations (Garfield, 2007). As with other bibliometric measurements, there are variations in article citation rates according to discipline and speciality. A detailed review of the citation rates for articles in the social sciences, medicine, and the natural sciences with engineering, showed that about one third (32%) of published articles in the social sciences field were uncited at five years post-publication, compared to 12% of articles in medicine and 27% of articles in the natural sciences with engineering (Larivière et al, 2009).

In the field of nursing, an analysis of all the articles published in the Journal of Advanced Nursing between 1995 and 2009 showed that around 1.5% had been cited more than 50 times (Hunt and Cleary, 2011). In a further analysis of published articles in the Journal of Advanced Nursing over a 30-year period, it was found that the mean number of citations for published articles was approximately 12 (Hunt et al, 2012). However, because this average is strongly affected by the few articles with frequent citations, most articles published in the journal would have been cited considerably less than 12 times.

The number of times an article is cited is a useful measure of its value, because it shows precisely how many times other authors have explicitly used, and referenced, the article in their own published works. However, as with other applications of citation counting, it is not an absolute measure of quality. Some types of article, such as reviews, clinical guideline summaries or articles that describe methods, especially biological, laboratory and statistical methods, might be more likely to be cited than other types of article (Uthman et al, 2013, Van Noorden et al, 2014). In addition, as with journal categories, the field of study has a considerable influence on citation counts. Articles in fields such as molecular and cell biology, immunology, and general medicine are more often cited than those based in anthropology and sociology (Althouse et al, 2009). To some degree, the difference in average citations evident between differing fields is related to differing conventions concerning the number of items included in the reference lists of published articles (Cross, 2005, Dong et al, 2005).

There are also differences between fields in the way that work is disseminated. For example, in the social sciences greater use is made of books to convey material than in the natural and biomedical sciences, whereas in engineering there is a greater tendency to publish work in conference proceedings rather than in traditional journals (Cross, 2005). These non-journal citations are not necessarily captured by the databases used by the available bibliometric tools. Article citations are also influenced by the age of articles: older articles have had additional time to be cited than those that are more recent, and so they will have higher citation values. Nonetheless, despite these issues,

the citation count for a particular article is an important indicator of its impact on the scientific community.

As a result of factors such as article age, field of study and publication type, it is challenging to attempt to provide a 'rule of thumb' about the number of article citations that denote article quality, importance and impact. However, some authors have suggested that for articles in nursing, those receiving ten citations are 'good' articles, 50 citations indicate 'very good' articles, 100 or more citations are 'excellent' articles, and more than 150 citations are 'exceptional' articles (Hack et al, 2010).

Author citations and the h-index

Alongside counting the number of times an article is referenced, citation counts may also be used to show the relative impact of individual authors. Electronic bibliographic databases and associated tools that enable the calculation of journal impact factors and article citation counts provide an efficient and accessible way to assess the contribution of individuals in terms of their publications. As with the other applications of bibliometrics, the process relies on the notion that the number of times a publication is referred to explicitly in other publications is an accurate reflection of its value and significance. Since publications are the primary means of disseminating research and providing systematic reviews of available evidence, being able to capture and report those outputs is a useful way of measuring an important part of the work of an academic. This type of citation analysis may be used to examine the performance of academics, and so may be part of the evaluations used for promotions, grant awards and membership of learned societies (Watson, 2009, Hack et al, 2010).

TIME OUT 5

Do you think that the number of publications is a useful measure of the activity and impact of an academic or researcher? Do you think the number of times a particular academic's articles are cited might be a more valid measure of their impact? What factors do you think might affect an individual author's citations? Reflect on these questions, considering: discipline or field, specialism within discipline, length of time articles have been published or 'academic age'.

An individual academic's published output can be measured by the total number of citations their published works have amassed, the highest number of citations for any one of their articles, or a composite measure called the *h*-index. The *h*-index (Hirsch, 2005) is the most widely used approach. It was developed in 2005 by Jorge Hirsch, a professor of physics at the University of California. It combines the number (quantity) of an individual's publications with the number of citations (quality) that these published works have generated (Hunt and Cleary, 2011). It focuses on the person's set of most highly cited articles by counting the number of articles that have been cited more than a certain number of times in an individual's total portfolio. Therefore, if someone has 11 articles that have each been cited 11 or more times, they have an *h*-index of 11. For the *h*-index to be increased by one unit, from 11 to 12, the person would need to have 12 articles that have each been cited at least 12 times.

Figure 1 shows an *h*-index graph for a person who has a total of 38 listed publications, each denoted by a dot along the x-axis or graph line, of which 30 articles have been cited at least once. One article has been cited 45 times, and the mean number of citations for this person's published articles is 8.1. Their *h*-index is 11, because they have 11 articles that have been cited 11 or more times. The *h*-index is useful because it provides a summary value of an academic's output that discounts the impact of

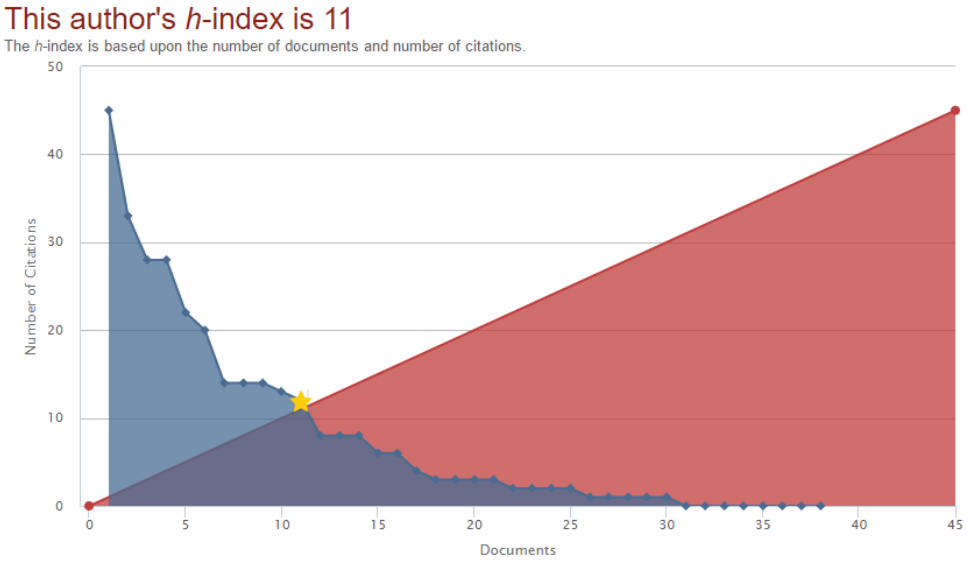
any highly-cited articles and ignores the effect of uncited articles, both of which will affect a simple average or mean value.

An important advantage of the *h*-index is that it avoids focusing on the total number of articles a person has published, which indicates little about the quality of these articles. 'Many publications' is not the same as 'many good publications'. The person's published works might consist of weak commentary and opinion pieces, unsystematic reviews, or poorly designed and conducted research studies. The way the h-index is calculated also avoids being based on total number of citations, which might be heavily influenced by a single publication that has generated a large number of citations, or by having many publications, each with few citations (Hirsch, 2005).

> **KEY POINT** An important advantage of the h-index is that it avoids focusing on the total number of articles a person has published, which indicates little about the quality of these articles. 'Many publications' is not the same as 'many good publications'. The person's published works might consist of weak commentary and opinion pieces, unsystematic reviews, or poorly designed and conducted research studies

An individual's *h*-index is related to the number of articles they have published and to how long they have been published for. Therefore, when comparing authors, it can be useful to consider the length of time the person has been active – the 'academic age' of a researcher – for example, by noting when their first article was published or when they were awarded their PhD. One guide for measuring academic output is for an individual to be expected to have one h-index unit for each year since the commencement of their academic work, denoted by the person's first publication or a marker such as a PhD award or academic post-commencement. A list of the most highly cited researchers is available at: www.webometrics.info/en/node/58. Although some of the researchers on this list have been deceased for some time, such as Sigmund Freud, who has more than 450,000 citations and an h-index of 266, many of the 1,612 most highly cited scientists with an h-index of 100 or more are still active and have exceeded typical benchmarks for academic achievement.

Figure 1: *h-index* graph



The *h*-index, like any other citation-count-based measure, can be affected by self-citation. It is conceivable that a person could focus their attention trying to get a particular article cited that was close to affecting their h-index. However, this would require considerable effort. It is simple to exclude self-citations from h-index calculations and other bibliometric methods, but this generally does not have much impact on a person's h-index (Hunt et al, 2011). Importantly, self-citations are not necessarily related to self-promotion or intellectual vanity. Many authors will conduct research and review work in specialist areas and it may often be highly appropriate that they consider and cite the previous work they have conducted and published on the topic.

TIME OUT 6

How many professors of nursing do you think there are in the UK? Do you think all of these professors have published articles that have been cited by others? Consider and discuss with your colleagues whether publishing, and having publications cited, is an important aspect and measure of scholarly credibility. Access displays of academic output for nurse academics, for example by checking Google Scholar Citations at: scholar.google.com/intl/en/scholar/citations.html or ResearchGate at: www.researchgate.net/home

The *h-index* and nurse academics

Watson et al (2017) explored the performance of professors of nursing in the UK by means of their publication records and extracted their h-indices using the Scopus electronic bibliographic database's author search function. Their analysis was facilitated by the Royal College of Nursing (2013) list of professors of nursing in the UK. Using the Scopus electronic database, Watson et al (2017) found that the mean h-index for UK professors of nursing was 12.66 (standard deviation 6.99), and that the h-index ranged from 0 to 35. The professors had been submitting works for publication for between 0 and 36 years, with a mean of 20 years. It was identified that several professors appeared to have no cited publications. The total citations for the individual professors of nursing ranged from 0 to 11,468.

Making scholarly outputs visible and accessible is important. One way of doing this may be to have internet researcher profile pages, such as those on an individual Google Scholar page, which are discussed in the next section of this article. However, fewer than one quarter of UK nurse professors were identified as having Google Scholar pages. As with all measures, a critical perspective concerning the validity, reliability and limitations of citation-based measures should be maintained, together with an awareness of the range of expertise relevant to nursing professor roles (Rolfe 2016).

Accessing bibliometric data

For people with subscription access to academic library facilities, detailed individual author and journal citation reports can be accessed via Web of Science and the bibliographic database Scopus (www.scopus. com). A free and easily accessible source of data is Google Scholar. In addition to article searching, this site provides journal impact rankings, and individual Google Scholar citation pages (scholar.google.com/ intl/en/scholar/citations.html) that host any registered academic's profile, listing their published outputs and generating citation and h-index data.

It is important to note that Google Scholar includes a range of publication types, including journal articles, books and conference reports. Therefore, the Google Scholar output lists, citations and h-indices are generally higher than those of Web of Science and Scopus, which are limited to articles

published in academic journals (Harzing and van der Wal, 2008). ResearchGate (www.researchgate.net/ home) is another easily accessible site that provides details of individual researchers' and institutions' publications, citations and other measures of impact.

Conclusion

Bibliometrics informs understanding of which journals in a discipline or field are most widely accessed and cited. This is important for libraries in deciding the most relevant journals to hold or purchase for their collections. It is also relevant for academic writers in deciding where they might publish their work. Bibliometrics can show networks of scholars and scholarly communication, links between scholars, and the development of areas of knowledge over time.

Citation counts and analyses provide a useful, and relatively objective, means of judging the impact of articles, and of their authors and institutions. For academics, the h-index is increasingly likely to be considered. However, the citation count and analysis approach to quality measurement has several flaws, principally because of the variations between fields and disciplines, and should be used prudently. It should not be the sole measure of importance and quality, nor can it replace the critical consideration of the value of a work.

More broadly, it is important to note that the impact of scholarship is complex, and there are various ways in which to make achievements in academia, engineer change and influence practice. Bibliometric measures provide an important, but partial, way of measuring impact; in particular, the h-index appears to be a useful and accessible measure with which to compare the scientific achievement of individuals.

TIME OUT 7

Nurses are encouraged to apply the four themes of The Code (NMC 2015) to their professional practice. Consider which of the themes of The Code may be relevant to published works, and whether bibliometric measures might have a role in judgements about the value and importance of publications.

TIME OUT 8

Now that you have completed the article you might like to write a reflective account as part of your revalidation

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